IS 6997 (1973): Test code for sugarcane crushers [FAD 20: Agriculture and Food Processing Equipments]

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Indian Standard

TEST CODE FOR SUGARCANE CRUSHERS

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TEST CODE FOR SUGARCANE CRUSHERS

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(*Continued on page* 16)

Indian Standard

TEST CODE FOR SUGARCANE CRUSHERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 April 1973, after the draft finalized by the Farm Implements and Machinery Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 A specification for sugarcane crushers (IS : 1973-1961*) was issued in 1961. While reviewing this standard, it was felt that detailed methods of routine and type testing should also be standardized. This test code is, therefore, being issued to serve as a guide for evaluating objectively the performance and constructional durability of sugarcane crushers. This test code is also intended to help the manufacturers in developing and the users in selecting good quality sugarcane crusher to meet their requirements.

0.3 In preparation of this standard, valuable assistance has been rendered by the Indian Institute of Technology, Kharagpur; National Sugar Institute, Kanpur; and Indian Sugarcane Research Institute, Lucknow.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies methods for type and routine testing of sugarcane crushers.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Absolute Juice — All the dissolved solids in the cane plus the total water of the cane, that is, cane minus fibre.

*Specification for sugarcane crusher, bullock-driven type.
†Rules for rounding off numerical values (*revised*).

2.2 Bagasse — The residue obtained after crushing the cane.

2.3 Brix — The percent by weight of solid matter as indicated by a brix spindle or calculated from other densimetric measurements.

2.4 Fibre — The dry water-insoluble matter in the cane.

2.5 Juice Extraction — The weight of juice extracted from cane by the crusher.

2.6 Pol — The value determined by direct or single polarization of the normal solution in a saccharimeter.

2.7 Routine Tests — Tests carried out on each crusher to check the requirements which are likely to vary during production.

2.8 Type Tests — Tests carried out on crushers to prove conformity with the requirements of the relevant standard. These are intended to prove the general qualities and design of a given type of crusher.

3. TYPE TESTS

3.1 The following shall constitute the type tests:

a) Checking of dimensions

b) Checking of material and hardness

c) Visual observations before run test

d) Test at no load

1) Power consumption — (for power-operated crushers only)

2) Visual observations

e) Test at load

1) Power consumption

2) Crushing capacity

3) Extraction capacity

4) Fibre percent in cane

5) Reduced juice extraction

6) Visual observations

4. ROUTINE TESTS

4.1 The following shall constitute the routine tests:

a) Visual observations before run test — [*see* **3.1** (c)].

b) Test at no load — [*see* **3.1** (d)].

1) Power consumption — [*see* **3.1** (d) (1)].

2) Visual observations — [*see* **3.1** (d) (2)].

5. CHECKING OF DIMENSIONS

5.1 The dimensions measured in millimetres shall be reported as given in Appendix A.

6. CHECKING OF MATERIAL AND HARDNESS

6.1 The material of construction of major components, hardness of rollers and other details shall be checked and reported as given in Appendix B.

7. VISUAL OBSERVATIONS BEFORE RUN TESTS

7.1 The observations as given in Appendix C shall be made visually and reported.

8. TEST AT NO LOAD

8.1 Install the crusher in accordance with manufacturer's recommendations and set the clearances as given below, ensuring that the clearances are uniform throughout the face length of rollers:

King to crushing roller	6·4 mm
King to extracting roller	0·8 mm

8.2 Operate the crusher for at least 30 minutes continuously at no-load. Animal power may be used for animal-drawn crushers and electric motor of appropriate power duly fitted with a powermeter shall be used for power-operated crushers.

8.3 Take the readings of powermeter at an intervals of 5, 10, 15, 20, 25 and 30 minutes. The average of difference between two consecutive readings shall give average power consumption for five minutes. Power consumption at no load for one hour shall be calculated and reported as given in Appendix D.

8.4 Observations during and after completing test at no load shall also be made and reported as given in **D-2**, for both animal-driven and power-operated crushers.

9. TEST AT LOAD

9.1 Pre-Test Requirements

9.1.1 Install and set the crusher as in **8.1**.

9.1.2 *Cane* — Take sufficient quantity of cane which should be free from field trash, roots, dirt, etc. The cane should, as far as possible, be of uniform diameter and length. Bundles of 25 kg of cane shall be prepared. The canes shall not be soaked in water before test.

9.2 Power Consumption

9.2.1 *Animal-Driven Crushers*

9.2.1.1 Operate the crusher by a pair of animal preterably bullocks for a period of one hour. The animal shall be properly attached with wooden beam by means of rope or chain and move at an average radius of 4·2 metres. A dynamometer shall be attached between beam and yoke for recording the pull.

9.2.1.2 Continuous feed of three canes at a time shall be maintained.

9.2.1.3 Revolutions shall be counted manually for the whole period of test and average revolutions per minute should be calculated. Average speed of 1·5 rev/min should be preferred.

9.2.1.4 The reading of dynamometer shall be taken for the whole period of test at an interval of 10 minutes. The average of the readings taken would represent the average pull required.

9.2.1.5 Power requirement shall be calculated by the following formula:

$$\text{Power requirement in kW} = \frac{\text{Pull in kgf} \times \text{Speed in m/s}}{75} \times 0.735\,5$$

OR

Power requirement in kW

$$= \frac{2\pi \times \text{Pull in kgf} \times \text{Radius of movement in m} \times \text{speed in rev/min} \times 0.735\,5}{4\,500}$$

9.2.1.6 Record the data as given in Appendix E.

9.2.2 *Power-Operated Crushers*

9.2.2.1 Power delivered to the crushers may be supplied either by direct coupling the prime mover with crusher, or by connecting the crusher with prime mover with the help of flat or V-belt and pulleys or by gears. In earlier case, the power delivered to the crusher would be the power output in the prime mover but in latter case the allowances for flat belt, V-belt and gear drive losses may be taken as 5, 2 and 10 percent respectively.

9.2.2.2 Operate the crusher by a suitable prime mover (electric motor preferred) for a period of one hour. The prime mover may be either direct coupled or may be connected with V-belts or flat belts or gears. A power meter or some form of transmission dynamometer shall be fitted.

9.2.2.3 Continuous feeding of three canes at a time shall be maintained.

9.2.2.4 The speed shall be measured by a revolution counter or by an accurately calibrated tachometer.

9.2.2.5 The reading of the power meter or dynamometer shall be taken for the whole period of test at an interval of 10 minutes

a) In case of power meter, the average of difference between two consecutive readings shall give average power consumption for 10 minutes. The power consumption at load for one hour shall be calculated giving allowances to type of drives (*see* **9.2.2.1**); and

b) In case of dynamometer the average of the reading taken shall give the average pull required. Power requirement shall be calculated by the formula given under **9.2.1.5** after giving the allowances to drive (*see* **9.2.2.1**).

9.2.2.6 The data shall be recorded as given in Appendix E.

9.3 Crushing Capacity

9.3.1 Operate the crusher in accordance with the method described in **9.2.1.1** and **9.2.2.2** with continuous feed of 3 canes at a time for a minimum period of one hour. The time of starting and stopping and any time lost during the test shall be recorded correctly.

9.3.2 Deduct, from the weight of cane taken for the test, the weight of cane left. The value thus obtained shall represent the weight of cane crushed during the period. The crushing capacity per hour may be obtained. The capacity per unit of energy consumed may also be calculated by following formula:

$$\text{Crushing capacity in kg/kWh} = \frac{\text{Cane crushed during one hour in kg}}{\text{Total energy consumed in kWh}}$$

9.3.3 Record the data as given in Appendix E.

9.4 Juice Extraction Capacity

9.4.1 Take minimum of 25 kg of cane and crush it by operating the crusher in accordance with **9.2.1.1** or **9.2.2.2** as the case may be.

9.4.2 The juice shall be collected in vessel of known weight. Juice shall be passed in vessel through a screen of preferably 180-micron IS Sieve. Care shall be observed that no juice is stuck with crusher or leaked through any source.

9.4.3 Take the weight of vessel containing juice after being sure that all the air from the juice have escaped.

9.4.4 Net weight of the juice shall be obtained by deducting the weight of vessel. Also record the temperature of the juice.

9.4.5 Carefully collect all the bagasse and take its weight.

9.4.6 From **9.4.4** and **9.4.5**, juice extracted and bagasse obtained for 100 kg of cane shall be calculated and data shall be recorded as given in Appendix E.

9.5 Fibre Content in Cane

9.5.1 The juice shall be analyzed for pol and brix according to the method given in Appendix F.

9.5.2 Bagasse shall be analyzed for pol and moisture content according to the method given in Appendix G.

9.5.3 Care shall be observed that bagasse shall be analyzed immediately after crushing and the juice shall be kept for settling in cool place for some time.

9.5.4 From analysis made in **9.4.6, 9.5.1** and **9.5.2** above, fibre in cane shall be calculated by following farmulae:

a) Purity of extracted juice $= \dfrac{\text{Pol percent}}{\text{Brix percent}}$

b) Brix percent bagasse $= \dfrac{\text{Pol percent bagasse}}{\text{Purity of extracted juice}} \times 100$

c) Fibre percent bagasse $= 100 - (\text{Moisture percent bagasse} + \text{Brix percent bagasse})$

d) Fibre percent cane $= \dfrac{\text{Fibre percent bagasse} \times \text{Bagasse percent cane}}{100}$

9.5.5 The data shall be recorded as given in Appendix E.

9.6 Reduced Juice Extraction

9.6.1 As juice extraction percent would vary according to fibre content in cane, for the purpose of uniformity and comparison of data, the juice extraction obtained in **9.4.6** shall be corrected on the basis of 12·5 percent fibre content in cane by the following formulae:

a) $E = 100 - \dfrac{V}{7}$

where

E = extraction reduced to 12·5 percent fibre, and

V = absolute juice in bagasse percent fibre.

b) $V = (100 - e) \times (100 - f)$

where

e = pol extraction = 100 — extraction (as recorded in **9.4.6**), and

f = fibre percent cane (as obtained under **9.5.4**).

9.6.2 The data shall be recorded as given in Appendix E.

9.7 Visual Observations — During and after completing the test at load, the observations mentioned in **E-6** shall be made visually and reported.

APPENDIX A

(*Clause* 5.1)

DIMENSIONAL DATA SHEET

1. Diameter of Roller
   a) King
   b) Crushing
   c) Extracting

2. Length of Roller
   a) King
   b) Crushing
   c) Extracting

3. Number of Grooves in Roller
   a) King
   b) Crushing
   c) Extracting

4. Diameter of Axle for Roller
   a) King
   b) Crushing
   c) Extracting

5. Diameter of Bearings
   a) King
   b) Crushing
   c) Extracting

6. Bearing and Axle Clearances
   - a) King
   - b) Crushing
   - c) Extracting

7. Length of Bearings
   - a) King
   - b) Crushing
   - c) Extracting

8. Roller Clearance Between
   - a) King and crushing
     - 1) Maximum
     - 2) Minimum
   - b) King and extracting
     - 1) Maximum
     - 2) Minimum

9. Gears
   - a) Number of gears
   - b) Number of teeth in gears
   - c) Length of gear teeth
   - d) Width of gear teeth
   - e) Height of gear teeth

Testing Engineer

APPENDIX B

(*Clause* 6.1)

MATERIAL AND HARDNESS DATA SHEET

1. Total Weight of Sugarcane Crusher
2. Hardness of Rollers at Machined Surface
3. Material of Construction of Different Components

Sl No.	Name of Part	Material
i	Rollers	
ii	Axles	
iii	Gears	
iv	Bearings	
v	Frame	
vi	Juice pan	
vii	Other parts	

Testing Engineer

APPENDIX C

(*Clause* 7.1)

DATA SHEET FOR VISUAL OBSERVATION BEFORE RUN TEST

1. Presence of Blow Holes, Cracks and Other Defects
2. Provision for Safety at Feeding Point
3. Provision of Sufficient Lubrication
4. Provision for Protection of Bearings from Entry of Juice
5. Provision for Covering of Gear Train in Power-Operated Crusher
6. Interchangeability of Parts
7. Attachment of Different Parts
8. Any Other Observation

Testing Engineer

APPENDIX D

(*Clauses* 8.3 *and* 8.4)

TEST AT NO LOAD DATA SHEET

1. Power Consumption
    a) Source of power
    b) Total time of run

c) Readings of powermeter at interval of five minutes
d) Average power consumption for five minutes
e) Average power consumption for one hour

2 Visual Observations

a) Presence of undue shock, hammering or other defects
b) Running of rollers and axles in their respective bearing
c) Rise in bearing temperature
d) Any marked unusual wear or slackness in any component
e) Smooth running of gear
f) Campactness and rigidity of construction
g) Any other observation

Testing Engineer

APPENDIX E

(*Clauses* 9.2.1.6, 9.2.2.6, 9.3.3, 9.4.6, 9.5.5, 9.6.2 *and* 9.7)

TEST AT LOAD DATA SHEET

1. Power Consumption

a) Type of power
b) Type of drive
c) Average reading of dynamometer or powermeter
d) Speed
    1) rev/min
    2) m/s
e) Average power consumption in kW

2. Crushing Capacity

a) Total weight of cane taken for test
b) Starting time
c) Stopping time
d) Time lost during the run
e) Total actual working time
f) Weight of cane left after run
g) Total weight of cane crushed
h) Crushing capacity:
    i) per hour
    ii) per kWh

3. Juice Extraction
    a) Total actual working time
    b) Total weight of cane crushed
    c) Weight of the vessel
    d) Weight of vessel with juice
    e) Weight of juice
    f) Temperature of the juice
    g) Weight of bagasse
    h) Juice obtained per 100 kg of cane
    j) Bagasse obtained per 100 kg of cane
    k) Any other matter obtained
4. Fibre Percent Cane
    a) Pol percent in juice
    b) Brix percent in juice
    c) Purity of juice
    d) Pol percent bagasse
    e) Brix percent bagasse
    f) Moisture percent bagasse
    g) Fibre percent bagasse
    h) Fibre percent cane
5. Reduced Juice Extraction
6. Visual Observations
    a) Presence of undue shock, hammering or other defects
    b) Running of rollers and axles in their respective bearing
    c) Rise in bearing temperature
    d) Compactness and rigidity of construction
    e) Running of gear train
    f) Any marked unusual wear or slackness in any component
    g) Any other observation

Testing Engineer

APPENDIX F

(*Clause* 9.5.1)

DETERMINATION OF BRIX AND POL OF JUICE

F-1. BRIX DETERMINATION

F-1.1 Procedure — Mix the juice thoroughly and pass through a sieve, preferably 106-micron IS Sieve. Fill a vertical cylinder to overflow.

Allow the air to escape by standing for 20 minutes; alternatively, the air may be removed by applying vacuum. Gradually lower the graduated brix spindle. Take the reading of the spindle in line with the plane surface of the liquid, after spindle becomes steady and attains the juice temperature. Also record the temperature of the juice by a thermometer.

The spindle reading at a particular temperature with spindle correction (if any) would give the brix content in juice at observed temperature.

The value thus obtained may be corrected at 20°C by the following formula:

$$S_{20} = S_t \left[1 + 0{\cdot}003 \, (t - 20) \right]$$

where

S_{20} = spindle reading at 20°C, and

S_t = spindle reading with spindle correction at t°C.

NOTE — This formula is applicable only up to 30°C.

F-2. POL DETERMINATION

F-2.1 Procedure — Mix the juice thoroughly and pass through a sieve, preferably 106-micron IS Sieve. Fill a 100-ml flask with juice and add about 0·6 g of dry acetate.

Place the stemless funnel over the glass cylinder and fix a cone of dry filter paper large enough to hold 100 ml in the funnel. Pour the whole of the defecated solution on the cone of the dry filter paper and cover it immediately with the watch-glass. Reject the first 10 to 15 ml of the filtrate. Rinse the glass cylinder with a little quantity of filtrate and discard the solution used for rinsing. Collect the remainder of the filtrate into rinsed cylinder. Polarize the filtrate in the saccharimeter at 20°C, as far as possible, using a 200-mm tube. The reading gives the polarization percent of the juice.

If the polarization is done at a temperature other than 20°C, the saccharimeter reading shall be corrected using the following formula:

$$S_{20} = S_t \left[1 + 0{\cdot}003 \, (t - 20) \right]$$

where

S_{20} = saccharimeter reading at 20°C, and

S_t = saccharimeter reading at t°C.

NOTE — The formula is applicable up to 30°C.

APPENDIX G

(*Clause* 9.5.2)

DETERMINATION OF MOISTURE CONTENT AND POL OF BAGASSE

G-1. MOISTURE CONTENT

G-1.1 Procedure — Take 100 g of the bagasse in weighed tray or basket, perforated on all sides. Dry in a suitable oven at about 110°C temperature. The loss in weight gives moisture percent bagasse.

G-2. POL DETERMINATION

G-2.1 Procedure — One kilogram of bagasse should be gently boiled for one hour under reflux with ten times its quantity of water. One gram of sodium carbonate per litre of water should be added in order to prevent inversion. The extract is clarified with anhydrous lead acetate. Filter the clarified extract and polarize the filtrate in the saccharimeter at 20°C as far as possible using 400-mm tube. After taking into account the moisture content in bagasse and the polarization in the 400-mm tube, the pol percent in bagasse may be calculated by the following formula:

$$\text{Pol percent in bagasse} = \frac{26\,P\,(W_1 + W_2)}{200 \times W_3}$$

where

P = polarization in 400-mm tube,

W_1 = weight of water taken,

W_2 = weight of water in bagasse, and

W_3 = weight of bagasse.

(*Continued from page* 2)

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